Efficient and Effective Rankings

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In the simple words of Peter Drucker, efficiency is doing things right while effectiveness is doing the right things. Efficient and Effective Rankings are ranking classifications for Decision-Making Units (DMUs) based on a combination of the efficiency score (obtained by parametric or non-parametric Data Envelopment Analysis frontier estimations) with a multiple effectiveness measure (often obtained using a Multicriteria Decision Analysis).
This study aims at providing a non-compensatory ranking classification combining Conditional Frontier Analysis with the PROMETHEE II methodology for the multidimensional efficiency and effectiveness analysis of Police. The results on Pernambuco (Brazil) Police departments offer interesting perspectives for public administrations concerning prioritizations of units based on the mitigation of resources and strategic objectives.

Data Envelopment Analysis | Conditional Frontier Analysis | PROMETHEE | Multicriteria Decision Analysis | Effciency | Effectiveness | Police Peformance | Crime | Violent Crime | Property Crime | Ranking | Pernambuco | Brazil | Sustainable Efficiency

1. Introduction

The sustainable development of a society requires the optimal usage of resources for the provision of goods and services and the ability to reach the desired social goals. Efficiency can be defined as the capacity to avoid wasting materials, resources, efforts, or time to produce a result or outcome. This concept is strictly related to sustainability. On the other hand, effectiveness can be defined as the ability of producing a desired result. This concept is strictly related to quality. In the simple words of Peter Drucker, efficiency is doing things right while effectiveness is doing the right things. These two perspectives are not always walking in the same direction and their potential conflict can jeopardize some of the promising prospects of sustainable service provisions, especially considering public administrations[1].

There is a recurrent trade-off between quality and efficiency in many empirical assessments [2][3][4]. Lo Storto [5], investigating the relationship between efficiency and effectiveness of public expenditure in 108 major Italian municipalities, suggests shreds of evidence for this trade-off involving public service quality indicators (expenditure effectiveness) and DEA measures for cost-efficiencies. Nepomuceno et al. [6], using the Complexity of Needs Model to investigate 88 public and private health service units in Pernambuco, Brazil, also offer support in addition to this discussion. According to the authors, most hospitalization-efficient units are crowded public hospitals

working at full capacity most of the year, which can only meet all the demand for hospitalizations (the output in the analysis) by compromising the service's quality.

Some composite indicators, such as the Civil Society Organization Sustainability Index developed by the United States Agency for International Development, offer an interesting methodology for measuring civil society's short-term quality in implementing development solutions and long-term achievement of sustainable outcomes. The index, which ranges from 1 (enhanced sustainability) to 7 (impeded sustainability), evaluates the legal environment, organizational capacity, financial viability, advocacy, service provision, sectorial infrastructure and public image of 82 countries. Other composite methodologies considering multiple perspectives for ranking regions are also provided in the scientific literature [7][8][9].

Ranking Decision-Making Units (DMUs) according to their productive performance has been the objective of Data Envelopment Analysis (DEA) applications in many sectors of economic activities for classifying both efficient and inefficient units[10][11][12]. Ranking service units provide valuable discriminations that support strategic decision-making by creating incentive structures for rewarding efficient managers, teams, resource allocations, recognizing prospective policies and best practices, changing misleading business competencies, operations, and activities, and developing sustainable directions for continuous improvement. It also offers clear information for taxpayers and society on investments' returns regarding public and state companies. Ranking police units under the influence of different environments, subjective value judgments, contexts and exogenous potentials of policing and criminality is challenging in the field of nonparametric efficiency analysis due to the stochastic nature of criminal occurrences.

Ranking service units also requires much effort in defining quality standards for the organization's products and services. Such a prospect is not limited to measuring decision units' technical efficiency with projections for how much outputs can be expanded and inputs contracted toward the industry's production capacity. It also extends to measuring how effective the decision unit is in achieving predefined objectives, which is strictly related to the quality of products and services. Multicriteria Decision Aid (MCDA) methods are a valuable source for systematic ranking multiple alternatives based on decision criteria weighted and evaluated by one or many decision-makers and stakeholders.

2. Methodology

Many DEA ranking methods in the Productive and Efficiency Analysis literature are considered post-analysis approaches[12]. The framework illustrated in Figure 1 can be situated in this classification. Four sub-ranks are constructed through pairwise comparisons. Compensations between efficiency and effectiveness are restricted with the imposition of vetoes for clustering effective/ineffective and efficient/inefficient alternatives (municipalities). The municipality is top-ranked when it is sufficiently effective according to the predefined objective and efficient in using the available resources to produce clear-ups for the specified felonies and misdemeanors. The second sub-rank has effective but not efficient municipalities, i.e., excellent efficiency prospects cannot offset poor effectiveness. If the municipality is efficient in using the available resources to solve crimes but is not effective in

reaching the specified institutional goal, it is located in the third sub-rank with similar municipalities. The last sub-rank has both ineffective and inefficient units. The PROMETHEE II net flow coefficient outranks the units in each sub-rank of this framework.

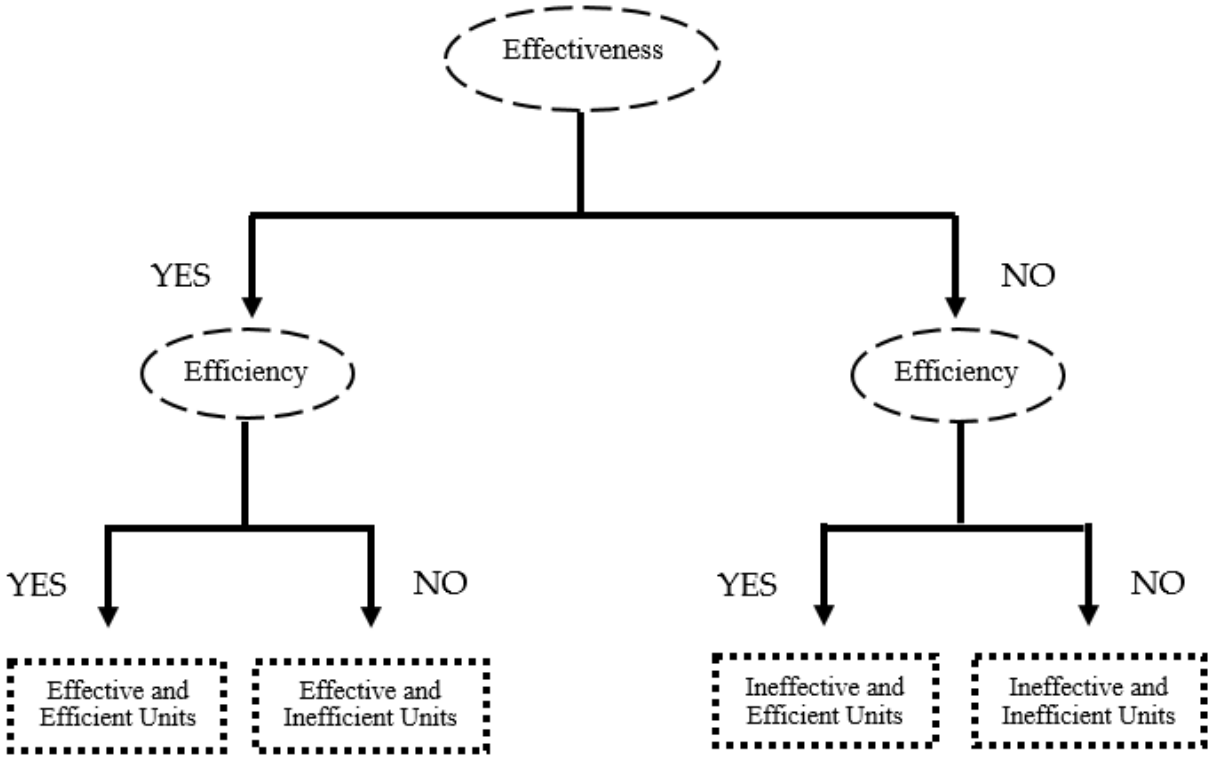

Figure 1. Framework for the Non-compensatory Ranking Methodology.

3. Data, Application and Discussion

Data regarding the number of police officers (input) and inquiries with the definition of responsibility (clear-ups) for three types of felonies (output), and the corresponding occurrences (Violent Crime, Street Mugging and Carjack) in 145 of the 185 Pernambuco cities were provided by the Secretariat for Social Defence (SDS-PE) [13]. The criminal occurrences are the environmental factors conditioning the directional efficiency of the police departments. Adequacy of this data can find support in similar assessments of police efficiency [14]. Table 1 and Figure 1 summarize the main descriptive data information.

Table 1. Data Descriptive Statistics.

Variable	Total	Min.	Max.	Median	Mean	1st Q.	3rd Q.	Std. Dev.
Input								

Officers	1430	3.000	48.000	8.000	9.862	6.000	11.000	6.36
Outputs								
Violent Crime	1212	0.000	42.000	5.000	8.359	3.000	11.000	9.24
Street Mugging	1334	0.0	79.0	5.0	9.2	1.0	10.0	13.24
Carjacking	298	0.000	25.000	1.000	2.055	0.000	2.000	3.89
Environmental Factors								
Violent Crime	2905	0.00	198.00	13.00	20.03	7.00	26.00	23.94
Street Mugging	20890	2.0	2198.0	42.0	144.1	19.0	135.0	300.9
Carjacking	10180	1.00	1161.00	25.00	70.21	11.00	63.00	127.92

The following tables report the overall Policing Effectiveness-Efficiency application for a non-compensatory ranking of 145 Pernambuco's municipalities described in the methodology. According to the results, none of the three completely efficient units (i.e., efficient in all three output models) are ineffective. For this reason, we have 3 sub-rankings instead of 4, as illustrated in Figure 1. The tables provide information on the non-compensatory compared

to the compensatory ranking position, i.e., when the municipalities are all outranked in the same group without the imposition of effectiveness or efficiency vetoes. The Net Flow parameter is used to outranking the units in each sub-rank.

Table 2. Effective and Efficient Units.

Position	Compensatory Position	DMUs	Net Flow	Effectiveness	Relative Inefficiency
1	18	Jucati	0.456	0.333	0.000
2	37	Saloá	0.279	0.250	0.000
3	69	Camocim de São Félix	0.006	0.154	0.000

Table 3. Effective and Inefficient Units.

Position	Compensatory Position	DMUs	Net Flow	Effectiveness	Relative Inefficiency
4	2	Cumaru	0.778	1.000	0.250
5	4	Lagoa do Ouro	0.686	0.600	0.333
6	10	Água Preta	0.579	0.500	0.333
7	11	Itaquitinga	0.545	0.444	0.200
8	19	Terezinha	0.452	0.600	0.400
9	26	Calçado	0.363	0.500	0.389

10	32	Jataúba	0.315	0.286	0.167
11	35	Joaquim Nabuco	0.284	0.500	0.381
12	36	Correntes	0.281	0.333	0.250
13	40	Jatobá	0.219	0.500	0.476
14	45	Moreilândia	0.205	0.667	0.541
15	46	Catende	0.195	0.432	0.466
16	47	Canhotinho	0.193	0.250	0.200
17	60	Quipapá	0.063	0.500	0.541
18	61	Araçoiaba	0.060	0.422	0.500
19	62	Petrolândia	0.053	0.400	0.458
20	67	Tabira	0.014	0.444	0.444
21	68	Santa Cruz	0.010	0.400	0.500
22	71	São Caitano	-0.006	0.187	0.259
23	76	Mirandiba	-0.033	0.500	0.545
24	78	Jaqueira	-0.039	0.272	0.428

25	79	Amaraji	-0.042	0.300	0.466
26	80	Ipubi	-0.051	0.307	0.444
27	85	Lagoa de Itaenga	-0.076	0.166	0.190
28	87	Agrestina	-0.083	0.333	0.444
29	90	Riacho das Almas	-0.098	0.250	0.428
30	91	Custódia	-0.103	0.4545	0.566
31	93	Ouricuri	-0.124	0.500	0.648
32	96	Tamandaré	-0.157	0.347	0.533
33	107	Floresta	-0.259	0.181	0.393
34	109	Angelim	-0.282	0.200	0.400
35	110	Brejo da Madre de Deus	-0.293	0.355	0.545
36	111	Águas Belas	-0.295	0.136	0.296
37	116	Palmares	-0.328	0.232	0.375
38	119	Bom Conselho	-0.364	0.250	0.444

39	121	Belém de Maria	-0.375	0.200	0.428
40	125	Cortês	-0.404	0.125	0.333
41	127	Araripina	-0.423	0.166	0.461
42	128	Aliança	-0.438	0.210	0.500
43	135	Toritama	-0.577	0.152	0.500
44	138	João Alfredo	-0.586	0.142	0.515
45	140	Sertânia	-0.599	0.181	0.518

Table 4. Ineffective and Inefficient Units.

Position	Compensatory Position	DMUs	Net Flow	Effectiveness	Relative Inefficiency
46	1	Paranatama	0.819	0.000	0.166
47	3	Jupi	0.761	0.000	0.0555
48	5	Goiana	0.681	0.000	0.288
49	6	Santa Terezinha	0.597	0.000	0.333
50	7	Venturosa	0.586	-0.166	0.208
51	8	Sanharó	0.586	-0.111	0.166

52	9	Casinhas	0.583	-0.182	0.166
53	12	Lajedo	0.542	-0.107	0.091
54	13	Iati	0.540	-0.166	0.266
55	14	Bezerros	0.529	0.020	0.354
56	15	Nazaré da Mata	0.512	0.100	0.424
57	16	Escada	0.459	-0.021	0.411
58	17	Ribeirão	0.456	0	0.416
59	20	Cabo de Santo Agostinho	0.443	-0.294	0.144
60	21	Macaparana	0.429	-0.111	0.375
61	22	Brejão	0.392	-0.166	0.333
62	23	Feira Nova	0.378	0.000	0.375
63	24	Camutanga	0.377	0.000	0.444
64	25	Tuparetama	0.377	0.000	0.444
65	27	Cupira	0.351	-0.464	0.111
66	28	Vitória de Santo Antão	0.339	-0.430	0.166

67	29	Limoeiro	0.336	-0.227	0.111
68	30	Vertentes	0.335	-0.315	0.285
69	31	Camaragibe	0.318	-0.277	0.363
70	33	Itambé	0.314	-0.111	0.416
71	34	Itaíba	0.310	0.000	0.476
72	38	Ferreiros	0.277	-0.333	0.166
73	39	Barreiros	0.265	-0.304	0.333
74	41	Capoeiras	0.219	-0.333	0.333
75	42	Sairé	0.209	-0.143	0.381
76	43	Belo Jardim	0.205	-0.589	0.143
77	44	Timbaúba	0.205	-0.307	0.372
78	48	Caetés	0.193	-0.363	0.333
79	49	Serrita	0.189	0.000	0.518
80	50	Taquaritinga do Norte	0.176	-0.500	0.333
81	51	Rio Formoso	0.155	-0.176	0.466

82	52	Sirinhaém	0.155	-0.518	0.200
83	53	Pesqueira	0.138	-0.272	0.285
84	54	Trindade	0.122	-0.210	0.407
85	55	Machados	0.090	-0.666	0.277
86	56	Arcoverde	0.086	-0.090	0.529
87	57	São José do Egito	0.080	0.000	0.545
88	58	Santa Maria da Boa Vista	0.077	-0.090	0.547
89	59	Ibimirim	0.074	-0.071	0,555
90	63	São Bento do Una	0.046	-0.280	0.500
91	64	Passira	0.041	-0.333	0.388
92	65	Belém do São Francisco	0.031	0.000	0.606
93	66	São Vicente Ferrer	0.019	-0.545	0.285
94	70	Tupanatinga	-0.002	-0.444	0.428
95	72	Serra Talhada	-0.014	-0.025	0.597
96	73	Paudalho	-0.017	-0.115	0.463

97	74	Afrânio	-0.020	-0.500	0.388
98	75	São João	-0.021	-1.000	0.200
99	77	São Benedito do Sul	-0.037	-1.500	0.166
100	81	Vicência	-0.053	-0.647	0.407
101	82	Panelas	-0.054	-0.727	0.375
102	83	São Joaquim do Monte	-0.063	-1.900	0.133
103	84	Lagoa Grande	-0.069	-1.000	0.333
104	86	Lagoa do Carro	-0.080	-1.375	0.208
105	88	Carpina	-0.083	-0.551	0.283
106	89	Gameleira	-0.089	-0.529	0.407
107	92	Barra de Guabiraba	-0.121	-1.166	0.333
108	94	Bonito	-0.133	-1.416	0.250
109	95	Santa Cruz do Capibaribe	-0.142	-0.288	0.473
110	97	Salgueiro	-0.168	-0.150	0.636

111	98	Tracunhaém	-0.172	-0.375	0.444
112	99	Bom Jardim	-0.173	-1.154	0.333
113	100	Chã Grande	-0.174	-0.666	0.388
114	101	Tacaimbó	-0.174	-0.666	0.388
115	102	Primavera	-0.175	-0.571	0.444
116	103	Moreno	-0.184	-0.311	0.388
117	104	Vertente do Lério	-0.207	-1.333	0.333
118	105	Altinho	-0.210	-1.500	0.200
119	106	Surubim	-0.214	-0.421	0.509
120	108	São José da Coroa Grande	-0.263	-1.277	0.407
121	112	Xexéu	-0.295	-0.714	0.458
122	113	Buíque	-0.299	-0.900	0.407
123	114	Palmeirina	-0.301	-1.000	0.4
124	115	Iguaraci	-0.306	-1.000	0.333
125	117	Flores	-0.338	-0.333	0.600

126	118	Orobó	-0.349	-3.000	0.333
127	120	São Lourenço da Mata	-0.368	-0.444	0.433
128	122	São José do Belmonte	-0.381	-0.375	0.600
129	123	Orocó	-0.390	-1.200	0.444
130	124	Betânia	-0.400	-1.000	0.476
131	126	Condado	-0.421	-2.000	0.380
132	129	Glória do Goitá	-0.485	-0.800	0.500
133	130	Alagoinha	-0.500	-2.000	0.388
134	131	Cabrobó	-0.518	-1.000	0.431
135	132	Terra Nova	-0.543	-2.000	0.444
136	133	Parnamirim	-0.557	-0.833	0.566
137	134	Itapissuma	-0.577	-0.833	0.583
138	136	Exu	-0.584	-1.600	0.500
139	137	Tacaratu	-0.585	-4.000	0.444
140	139	Gravatá	-0.587	-1.000	0.500

141	141	Carnaíba	-0.637	-3.000	0.4762
142	142	Chã de Alegria	-0.647	-1.500	0.500
143	143	Bodocó	-0.710	-1.333	0.566
144	144	Pombos	-0.727	-1.571	0.500
145	145	Afogados da Ingazeira	-0.780	-1.333	0.608

The effectiveness is measured in how much the municipality has reached the target of 12% reduction in homicides (so more is preferable, but 0.12 is sufficient). The last column for the relative inefficiency aggregates each unit's relative inefficiency scores for all the three models considering the slacks (so less is preferable and zero means the unit is efficient in all three models, with no slack for police officers). It is interesting how different the non-compensatory top-ranked municipalities would feature in a compensatory evaluation. Jucati, the first top-ranked municipality, is a small city in the *agreste pernambucano* (rural / wasteland region) of about 11 thousand residents and a population density of 87.92 per km². It had 4 officers as input along the year, 4 homicide occurrences (all solved), 12 street mugging (10 solved) and 15 carjackings (8 recovered). The municipality reduced from 9 homicides in 2015 to 6 homicides in 2016 (about 33% reduction) and from 6 homicides in 2016 to 4 homicides in 2017 (about 33% reduction).

When compared to the first effective but not efficient unit (Cumaru, Table 2) we can observe the compensation effect: because Cumaru, another small city in Pernambuco, could reduce the homicides entirely in the year of evaluation (from 2 to zero, 100% effectiveness, w = 0,5208333) this more than compensates a poor efficiency performance (25% relative inefficiency), locating this municipality in the second position in the Compensatory Ranking, and Jucati in the 18º. Compensations of this nature can be observed all over the rankings. Non-compensatory / Compensatory ranking inversions are even bigger for Saloá (2 compared to 37) and Camocim de São Félix (3 compared to 69). The Non-compensatory ranking of units in this assessment tends to provide a fairer evaluation in line with what is expected by the policymaker.

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